The World's Reactors

No. 36 NPD—Nuclear Power Demonstration

CHARACTERISTICS OF NPD

LOCATION	Rolphton, Ontario, Canada
OWNERS	Atomic Energy of Canada, Ltd., and Hydro-Electric Power Commission of Ontario
OPERATOR	Hydro-Electric Power Commission of Ontario
DESIGNERS	
Reactor Plant	Canadian General Electric Company, Ltd.
Conventional Plant	Hydro-Electric Power Commission of Ontario
PRIME CONTRACTOR	Canadian General Electric Company, Ltd.
OPERATION	
Critical	April 11, 1962
Full Power	June 28, 1962
OUTPUT	
Thermal	82·5 MW
Electrical	20 MW (Gross) 17·5 MW (Net)
CALANDRIA	
Form	Horizontal cylinder, double shell
Material	Alcan 57S aluminium alloy
Nominal diameter	17 ft
Overall length	15 ft
Inner wall thickness	¼ in
Outer wall thickness	
Sides	½ in
Ends	1½ in
Calandria tube	
Inner diameter	4 in
Wall thickness	0·054 in

REFLECTOR	*Primary*	*Secondary*
Material	Heavy water	Ordinary water
Form	Liquid annulus	Liquid annulus
Quantity	34 600 lb	100 000 lb
Radial thickness		
At centre	21·6 in	Min 11·8 in (part shield)
At ends	5·6 in	

CORE		
Shape	Horizontal prism, modified octagonal	
Number of cells	132	
Lattice type	Square	
Lattice pitch	10·25 in	
	Outer	*Inner*
Sites	80	52
Fuel	7 element	19 element
Cross-section of UO_2	32 cm²	31·1 cm²
Sheath effective cross-section	4·78 cm²	4·49 cm²
Coolant effective cross-section	16·60 cm²	17·84 cm²
Total cell area	678 cm²	
Effective core length	384 cm	
Effective core diameter	337·5 cm	
Moderator (D_2O) volume	1 200 ft³	
Fuel burn-up	6 300 MWd/t(U)	
Active zone fuel capacity	$16·7 \times 10^6$ g	

FUEL		
Form	Sintered natural UO_2 pellets	
Cladding	Zircaloy–2	
Length of bundle	19½ in	
Diameter of bundle	3½ in approx.	
	80 *outer sites*	52 *inner sites*
Type of bundle	7 element	19 element
Number of bundles/channel	9	9
Total number of bundles	720	468
Number of pellets/element	21	24
Length	0·890 in	0·782 in
Dia. of pellets	0·943 in	0·563 in
Min. cladding thickness	0·0214 in	0·015 in
Max. internal temperature	2 450°F	1 500°F
Max. heat flux	146 000 Btu/ft² h	148 000 Btu/ft² h
Mean sheath temperature	555°F	550°F

NUCLEAR DESIGN DATA	
Moderator	Heavy water
Thermal neutron flux	
Fuel average at core centre	$4·2 \times 10^{13}$ n/cm² s
Moderator average at core centre	$7·9 \times 10^{3}$ n/cm² s
Ratio, core average to maximum	0·42

PRIMARY HEAT TRANSPORT SYSTEM

General	
Coolant	Heavy water
Quantity	22 000 lb
Total flow	$5·14 \times 10^6$ lb/h
Temperature	
Inlet	485°F
Outlet	530°F
Pressure	
Inlet header	1 166 psig
Outlet header	1 070 psig
Coolant velocity	15·6 ft/s in central fuel channel
Boiler	
Number and type	1 horizontal " U shell and tube " heat exchanger with steam drum
Tube surface area	6 200 ft²
Tube material	Inconel
Total evaporation rate	300 000 lb/h
Heavy water velocity	15·4 ft/s
Heavy water pressure drop	21·1 psi
Feed-water inlet	300°F
Primary coolant pumps	
Number and type	3 shaft-sealed centrifugal at 50%
Capacity (each)	6 000 gal (U.S.)/min
Operating head	140 psi
Electrical rating (each)	800 hp
Material	11–13% chrome steel
Primary coolant piping	
Material	ASTM Type A106 Schedule 80 carbon steel
Main piping diameter	16 in
Dump branch diameter	10 in
Feeder pipe diameter	1½ in
Stand-by Cooling Circuit	
Heavy water flow rate	120 gal (U.S.)/min
Pumps	2–50% at 1·5 hp (each)
Cooler	
Number and type	1 " shell and tube " heat exchanger
Heat duty	1·0 MW

MODERATOR AND HELIUM SYSTEM

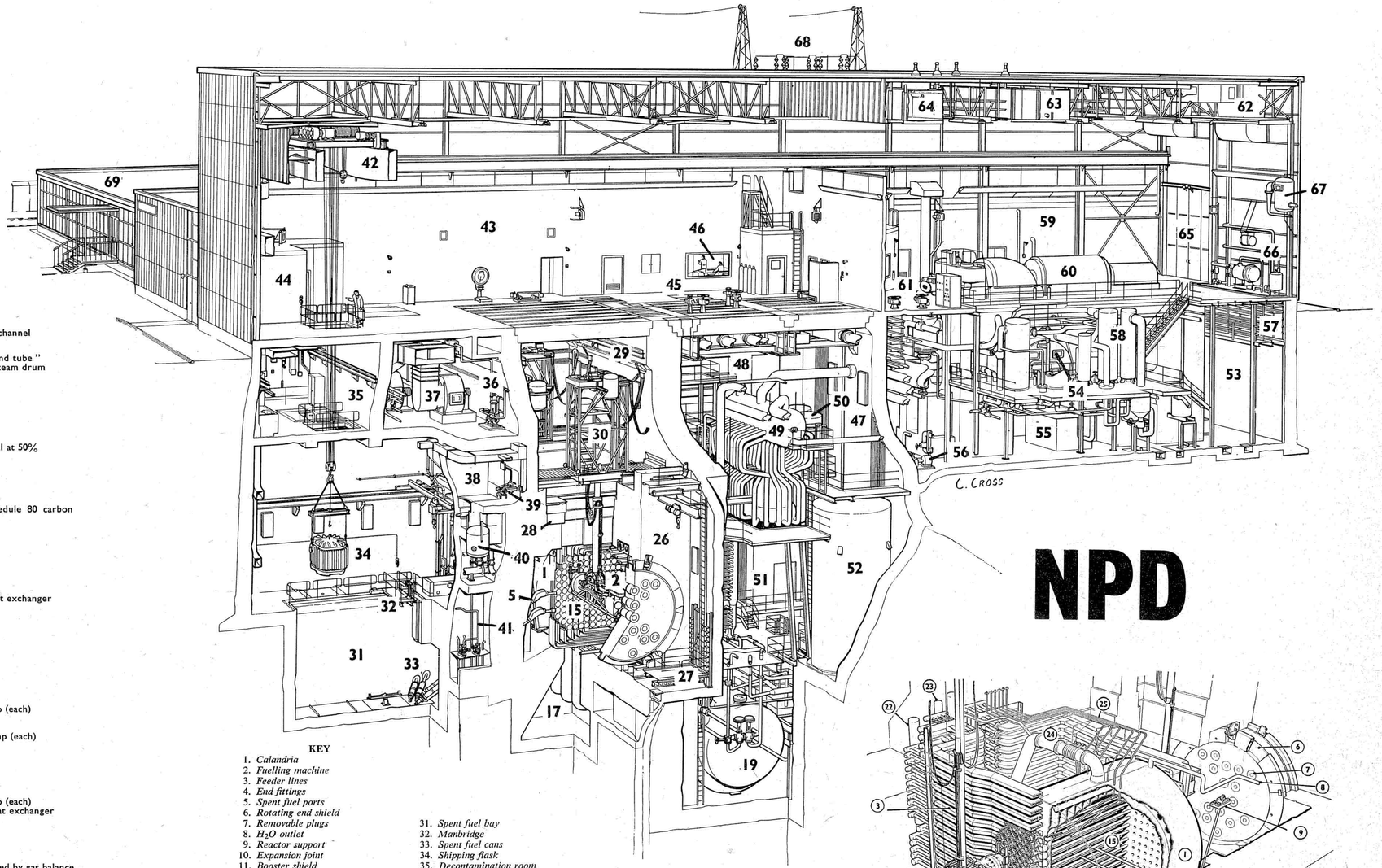
Moderator cooling	
Flow rate	1 560 gal (U.S.)/min
Normal temp. range	120°F–180°F
Heat exchanger	
Number and type	1 shell and tube
Heat duty	6·5 MW
D_2O pumps	3–50% capacity at 50 hp (each)
Helium circuit	
Gasholder capacity	1 500 ft³
Helium blowers	2–100% capacity at 10 hp (each)
Helium flow rate	180 ft³/min

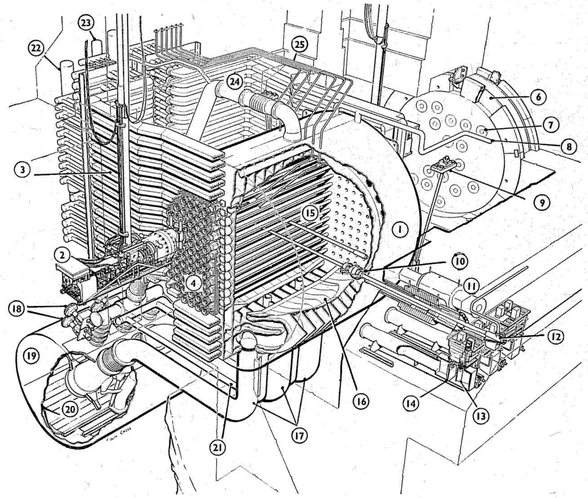
REFLECTOR SYSTEM

Light water flow rate	1 200 gal (U.S.)/min
Pump	3–50% capacity at 10 hp (each)
Cooler	1 " shell and tube " heat exchanger

CONTROL SYSTEM

Regulating System	
Fine control	Moderator volume, varied by gas balance system
Positive reactivity rate while under rated operation	0·04 mk/s
Maximum possible positive reactivity while critical (cold critical at half tank)	0·29 mk/s
Coarse Control	
Booster rod	1 motor-driven
1 rod worth	2·5 mk
Max. reactivity rate	0·01 mk/s approx.
Moderator Temperature	
Range	120°F–180°F (Temperature can be lowered to 90°F after dumping)
Temperature coefficient	−0·013 mk/°F for equilibrium fuel
Control sensitivity	Steam pressure held within ± 2%
Shutdown System	Moderator completely evacuated from calandria (total worth 1 000 mk). In one second, reactivity is reduced 3 mk. In four seconds, reactivity rate is 20 mk/s.





KEY

1. *Calandria*
2. *Fuelling machine*
3. *Feeder lines*
4. *End fittings*
5. *Spent fuel ports*
6. *Rotating end shield*
7. *Removable plugs*
8. *H_2O outlet*
9. *Reactor support*
10. *Expansion joint*
11. *Booster shield*
12. *Booster rod drive*
13. *Ion chamber*
14. *Scatterer*
15. *Coolant tubes*
16. *Dump slot*
17. *Dump lines*
18. *Dump valves*
19. *Dump tank*
20. *Baffle*
21. *Moderator inlet*
22. *Coolant inlet header*
23. *Outlet header*
24. *Helium line*
25. *Spray cooling*
26. *Tube withdrawal room*
27. *Working platform*
28. *Shielding gate*
29. *Fuelling machine room*
30. *Machine carriage*
31. *Spent fuel bay*
32. *Manbridge*
33. *Spent fuel cans*
34. *Shipping flask*
35. *Decontamination room*
36. *Reactor vault cooling*
37. *Main circulating fan*
38. *New fuel room*
39. *New fuel port*
40. *Active auxiliaries*
41. *Clean-up room*
42. *25-ton crane*
43. *Reactor hall*
44. *Radiation office*
45. *Primary valve actuator*
46. *Control room*
47. *Boiler room*
48. *Dousing tanks*
49. *Steam generator*
50. *Primary pumps*
51. *Header*
52. *Helium tank*
53. *Condenser room*
54. *Main condenser*
55. *Turbine block*
56. *Boiler feed pump*
57. *Cable gallery*
58. *Heaters*
59. *Turbine hall*
60. *Turbo-generator*
61. *Main steam valve*
62. *Air conditioner*
63. *Reserve water tank*
64. *Surge tank*
65. *Truck entrance*
66. *No. 1. H.E.*
67. *Regulating tank*
68. *Transformer*
69. *Office wing*